

CLAIMS

1. A power-assisted bicycle of a type adding an assisting power in accordance with a pedaling power acting on a drive shaft; comprising:

a one-way clutch system connecting said drive shaft to a sprocket for transmitting substantially only an one-way rotation of said drive shaft to said sprocket;

a detection system for detecting a physical amount varying with deformation of said one-way clutch system in accordance with said pedaling force; and

a control system for controlling said assisting power on the basis of at least the physical amount detected with said detection system.

2. The power-assisted bicycle as claimed in claim 1, wherein said one-way clutch system is deformed expanding or contracting to a length in accordance with said pedaling force in the axial direction of said drive shaft.

3. The power-assisted bicycle as claimed in claim 1, wherein said one-way clutch system acts elastically to return the deformation to an original shape.

4. The power-assisted bicycle as claimed in claim 3, wherein an elastic member is disposed so as to resist deformation of said one-way clutch system and to provide at least a portion of the elasticity.

5. The power-assisted bicycle as claimed in claim 3, wherein an elastic member is in a generally flat form having a height smaller than a latitudinal width and disposed with its height direction arranged in the

direction of deformation of said one-way clutch system.

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6. The power-assisted bicycle as claimed in claim 4 or 5, wherein said detection system detects stress deformation of said elastic member as said physical amount.

7. The power-assisted bicycle as claimed in any one of claims 1 to 5, wherein said detection system detects the position of at least one of parts structuring said one-way clutch system relative to the body frame as said physical amount.

8. The power-assisted bicycle as claimed in any one of claims 1 to 5, wherein said detection system detects a relative position relationship between at least two parts structuring said one-way clutch system as said physical amount.

9. The power-assisted bicycle as claimed in any one of claims 1 to 5, wherein said detection system detects a variation in pressure in resistance to a direction of deformation of said one-way clutch system as said physical amount.

10. The power-assisted bicycle as claimed in claim 1, wherein said one-way clutch system is a ratchet gear.

11. The power-assisted bicycle as claimed in claim 10, wherein said ratchet gear is arranged to deform expanding or contracting to a length in accordance with said pedaling force in the axial direction of said drive shaft.

12. The power-assisted bicycle as claimed in claim 11, wherein said ratchet gear comprises:

a tooth part with a plurality of ratchet teeth formed

on a first engagement face; and

a piece part with a plurality of ratchet pieces formed on a second engagement face;

wherein said first engagement face and said second engagement face are disposed facing each other in a generally vertical direction to said axial direction; and

wherein said ratchet piece is engaged with said ratchet tooth to halt a relative rotation between said piece part and said tooth part, when said drive shaft implements said substantial one-way rotation, and said ratchet piece is disengaged with said ratchet tooth to enable said relative rotation, when said drive shaft implements a reverse rotation opposite to said substantial one-way rotation.

13. The power-assisted bicycle as claimed in claim 12, wherein:

each of said plurality of ratchet teeth comprises a sharply sloping face and a gradually sloping face, which are disposed alternately and periodically on said first engagement face in a peripheral direction of said tooth part;

said ratchet pieces are mounted on said piece part so as to vary an angle with said second engagement face; and

said ratchet piece is engaged with said sharply sloping face, when said drive shaft implements said substantial one-way rotation, and said ratchet piece abuts with said gradually sloping face, when said drive shaft implements said reverse rotation.

14. The power-assisted bicycle as claimed in claim 12, wherein either one of said tooth part and said piece part is mounted on said drive shaft through a rotation-preventive system for preventing a relative rotation with respect to said drive shaft yet allowing a sliding movement in said axial direction, and the other of said tooth part and said piece part is connected to said sprocket.

15. The power-assisted bicycle as claimed in claim 14, wherein either one of said tooth part or said piece part mounted slidably in said axial direction through said rotation-preventive system is supported so as to permit an elastic unit to abut with a rear face opposite to an engagement face thereof.

16. The power-assisted bicycle as claimed in claim 15, wherein said detection system is a deformation detection sensor for detecting a stress deformation of said elastic unit.

17. The power-assisted bicycle as claimed in claim 15, wherein said detection system comprises a position sensor for detecting the axial position of either one of said tooth part or said piece part mounted slidably on said drive shaft with respect to a body frame.

18. The power-assisted bicycle as claimed in claim 15, wherein said detection system comprises a position sensor for detecting a clearance between said tooth part and said piece part.

19. The power-assisted bicycle as claimed in claim 15, wherein said detection system comprises a sensor for

detecting a deformation of said ratchet piece with respect to said second engagement face.

20. The power-assisted bicycle as claimed in claim 15, wherein said detection system comprises a piezoelectric sensor for detecting a pressure of said elastic unit applied from said rear face.

21. The power-assisted bicycle as claimed in claim 15, wherein said elastic unit comprises a disc spring.

22. The power-assisted bicycle as claimed in claim 21, wherein said disc spring is provided with a plurality of strain gauges as said detection system.

23. The power-assisted bicycle as claimed in claim 22, wherein said control system assumes a pedaling force for determining said assisting power by subjecting signals from said plurality of strain gauges to at least an addition operation.

24. ~~The power-assisted bicycle as claimed in claim 22 or 23, wherein said plurality of strain gauges are disposed on a surface of said disc spring in positions rotation-symmetrical to each other.~~

25. The power-assisted bicycle as claimed in claim 15, wherein said elastic unit is a coil spring.

26. The power-assisted bicycle as claimed in claim 15, wherein said elastic unit is made of an elastic rubber.

27. The power-assisted bicycle as claimed in any one of claims 15 to 26, wherein an offset elastic member is disposed, which deviates either one of said tooth part or said piece part so as to create a clearance between said

rear face and said elastic unit, when said pedaling force is lower than a predetermined value.

28. The power-assisted bicycle as claimed in claim 15, wherein said elastic unit is supported with a supporting member mounted on said drive shaft so as to be rotatable and axially slidable.

29. The power-assisted bicycle as claimed in claim 28, wherein said supporting member is connected to said sprocket.

30. The power-assisted bicycle as claimed in claim 28, wherein said supporting member is a hollow cylindrical member and supports said elastic unit at a bottom face inside said hollow cylindrical member.

31. The power-assisted bicycle as claimed in any one of claims 28 to 30, wherein said supporting member is mounted on said drive shaft through a bearing.

32. The power-assisted bicycle as claimed in claim 15, wherein said rear face of either one of said tooth part or said piece part with which said elastic unit abuts is provided with a loading bearing or a sliding bearing.

33. The power-assisted bicycle as claimed in claim 32, wherein said bearing is composed of a plurality of steel balls inserted rotatably into a circular groove formed in said rear face.

34. The power-assisted bicycle as claimed in claim 15, wherein said rotation-preventive system is composed of a ball spline.

35. The power-assisted bicycle as claimed in claim 15,

wherein either one of said tooth part and said piece part mounted slidably in said axial direction is provided with a bore which accommodates said drive shaft.

36. The power-assisted bicycle as claimed in claim 35, wherein said rotation-preventive system comprises one or more rows of first grooves formed in an inner wall of said bore and extending in said axial direction, one or more rows of second grooves formed in said drive shaft opposite to said first grooves and extending in said axial direction, and steel balls to be accommodated in said first and second grooves.

37. The power-assisted bicycle as claimed in claim 35, wherein said rotation-preventive system comprises one or more rows of first grooves formed in an inner wall of said bore and extending in said axial direction, one or more rows of second grooves formed in said drive shaft opposite to said first grooves and extending in said axial direction, and plates to be accommodated in said first and second grooves.

38. The power-assisted bicycle as claimed in claim 35, wherein said rotation-preventive system comprises one or more rows of grooves formed in an inner wall of said bore and extending in said axial direction, and one or more rows of protruding portions formed in said drive shaft so as to be accommodated in said grooves.

39. The power-assisted bicycle as claimed in claim 35, wherein said rotation-preventive system comprises one or more rows of protruding portions formed in an inner wall of

said bore and extending in said axial direction, and one or more rows of grooves formed in said drive shaft so as to accommodate said protruding portions.

40. The power-assisted bicycle as claimed in claim 35, wherein said rotation-preventive system comprises a plate member extending over the entire diameter of said bore and connected to an inner wall of said bore, and a through groove formed in said drive shaft penetrating throughout said drive shaft in said axial direction; and

wherein said plate member is slidably fitted into said through groove.

Sub 41. The power-assisted bicycle as claimed in any one of claims 15 to 29, wherein said ratchet piece is composed of a rigid body and arranged so that its lengthwise direction pivots about a direction at a given angle with respect to said second engagement face.

42. The power-assisted bicycle as claimed in claim 15, wherein said ratchet piece is composed of an elastic member.

43. The power-assisted bicycle as claimed in claim 42, wherein said detection system is a deformation detection sensor for detecting a stress deformation of said ratchet piece.

44. The power-assisted bicycle as claimed in claim 42, wherein said detection system is a position sensor fixed to a bicycle body frame for detecting the amount of the axial displacement of said tooth part.

Sub 45. The power-assisted bicycle as claimed in any one of claims 10 to 14, wherein an elastically holding unit having

elasticity for rotatably holding said sprocket on a bicycle body frame is disposed such that it resists deformation of said one-way clutch system.

46. The power-assisted bicycle as claimed in claim 45, wherein said detection system is a deformation sensor for detecting a stress deformation of said elastically holding unit.

47. The power-assisted bicycle as claimed in claim 45, wherein said elastically holding unit holds said sprocket so as to provide a region where an axial width of said one-way clutch system overlaps with an axial width of said elastically holding unit in an axial position.

48. The power-assisted bicycle as claimed in claim 45, wherein said elastically holding unit holds said sprocket from the side at which said one-way clutch system is mounted on said sprocket and from the opposite side.

49. The power-assisted bicycle as claimed in claim 48, wherein:

said sprocket has an elongated hollow cylindrical portion extending toward a one plate face side from a sprocket side;

said one-way clutch system is accommodated in a hollow portion inside said elongated hollow cylindrical portion; and

said elastically holding unit holds said sprocket from the outer periphery of said elongated hollow cylindrical portion.

50. The power-assisted bicycle as claimed in claim 49,

wherein a bearing is engaged in the outer periphery of said elongated hollow cylindrical portion; and said elastically holding unit holds said bearing and fixes said bearing to a bicycle body frame.

51. The power-assisted bicycle as claimed in claim 50, wherein said bearing is disposed to withstand a load from a radial direction and the axial direction.

52. The power-assisted bicycle as claimed in claim 50, wherein said elastically holding unit is formed to support in a state in which said bearing is covered therewith, and a one end portion thereof is composed of an elastic body in a disc form fixed to a bicycle body frame.

53. The ~~power-assisted~~ bicycle as claimed in any one of claims 1 to 52, wherein said assisting power is transmitted through a ~~sprocket drive gear~~ engaged with said sprocket.